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**From:** Ex. 4 CBI Ex. 4 CBI

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**Subject:** CBP Technical Support TD #13: Draft statistical survey procedures for developed sector BMP verification

## 1.0 Summary

This technical memorandum presents the draft statistical survey procedures for developed sector best management practice (BMP) verification under Technical Direction (TD) #13. The goal of the project is to refine New York's developed sector BMP verification protocols for the Chesapeake Bay watershed by selecting a statistically random subsample to validate the existence and performance of BMPs where large implementation numbers do not allow for the verification of each individual BMP.

Section 2.0 of this memo presents the BMPs to be included in New York State Department of Environmental Conservation's (DEC's) revised BMP verification protocols for the developed sector. Section 3.0 presents the draft statistical sample design to be applied for verification and Section 4.0 presents a summary of how the statistical sample design will be incorporated into New York's *Quality Assurance Project Plan Procedures for Collecting, Reporting and Verifying Wastewater and Developed Sector Data in the Chesapeake Bay Watershed* (NYSDEC 2019).

## 2.0 BMP Inclusion Approach

The BMPs to be included in the statistical survey procedures for the developed sector were identified using the Nonpoint Source BMP Database description provided by DEC, New York's *Phase III Watershed Implementation Plan* (WIP) for the Chesapeake Bay (NYSDEC 2020) and New York's *Quality Assurance Project Plan Procedures for Collecting, Reporting and Verifying Wastewater and Developed Sector Data in the Chesapeake Bay Watershed* (QAPP) (NYSDEC 2019). The BMPs are discussed in more detail in Sections 2.1 and 2.2 and [ REF \_Ref44325724 \h ] presents a summary of all developed sector BMPs considered for inclusion.

### 2.1 Included BMPs

The BMPs identified by the Phase III WIP as "those proposed to meet the 2025 developed sector target" (NYSDEC 2020) include stormwater performance standard runoff reduction BMPs, stormwater performance standard stormwater treatment BMPs, urban nutrient management plans, and urban forestry (forest buffers, tree planting) (NYSDEC 2020); however, other types of BMPs are also implemented in the watershed.

New York has historically only submitted BMPs associated with construction stormwater general permits to the Environmental Protection Agency's (EPA's) Chesapeake Bay Program (CBP) for annual progress but the revised verification protocols for the developed sector will apply to almost all BMPs implemented outside of multiple separate storm sewer system (MS4) areas and federal facilities. New York is currently developing a BMP

database to track all BMPs implemented in the watershed and is planning on reporting all implemented BMPs to the CBP in the future.

DEC's BMP database is set up to input developed sector BMPs into seven different templates (construction stormwater, harvested forest, regional planning, urban forestry, Water Quality Improvement Projects [WQIPs], MS4s, and federal facilities). The BMPs types from these seven templates that are included in the verification protocols include (see [ REF \_Ref44325724 \h ]):

- Impervious surface reduction
- Stormwater performance standard (runoff reduction)
- Stormwater performance standard (stormwater treatment)
- Forest harvesting practices
- Septic connections
- Urban stream restoration
- Urban nutrient management
- Wetland enhancement/rehabilitation
- Forest buffers
- Forest planting
- Tree planting
- Grass buffers

## 2.2 Excluded BMPs

Erosion and sediment control practices are not included in the verification protocols. Section 7.1.1.2 of the existing QAPP states that "Because the Chesapeake Bay Program does not differentiate between types of erosion and sediment control practices for purposes of the Chesapeake Bay Watershed Model, New York only reports the total acreage treated by erosion and sediment control practices". All construction sites that disturb greater than one acre in New York require a construction stormwater general permit. The permit requires Level 2 erosion and sediment control on 100% of construction areas (NYSDEC 2020 and NYSDEC 2019). New York reports its annual acres of construction and there is no further need for verification based on 100% implementation and inspection of erosion and sediment control.

Septic system pumping is another BMP that will not be included in the verification protocols. DEC does not expect significant nitrogen reductions from onsite wastewater treatment systems (OWTS) and does not currently track, report or verify OWTS BMPs in the Chesapeake Bay watershed (NYSDEC 2019).

BMPs associated with the MS4 permits in Binghamton and Elmira will also not be included in the verification protocols because there is an existing tracking and reporting requirement through the MS4 permit. Section 7.1 of the verification QAPP states "the MS4 Program requires post-construction BMPs to be implemented by regulated municipalities as part of the fulfillment of Minimum Control Measure 5 (MCM5) in their permits. Procedures to track and inventory post-construction stormwater practices are required" (NYSDEC 2019). New York's MS4 permits are currently being revised. If the updated permits are available prior to the final revision of the verification protocols, language will be included to describe the MS4 inspection requirements including the types of BMPs to be inspected and the frequency of inspection.

BMPs at federal facilities will not be included because these facilities have their own verification procedures.

**Table [ SEQ Table \\* ARABIC ]. BMPs considered for inclusion in the developed sector verification protocols**

BMP Template	BMP Name/ID	Include in survey (Yes/No)	Additional information
Construction stormwater	Impervious surface reduction	Yes	<ul style="list-style-type: none"> <li>Stormwater performance standard BMPs will be sampled as two groups (runoff reduction and stormwater treatment) rather than being sampled as each individual type of BMP associated with each performance standard BMP (e.g., bioretention, infiltration, filtering practices, etc...)</li> <li>Erosion &amp; sediment control will not be included because it is already reported at 100%</li> </ul>
	Stormwater Performance Standard (Runoff Reduction) <ul style="list-style-type: none"> <li>Bioretention/raingardens</li> <li>Infiltration practices</li> <li>Permeable pavement</li> <li>Urban filter strips</li> <li>Vegetated open channels</li> </ul>		
	Stormwater Performance Standard (Stormwater Treatment) <ul style="list-style-type: none"> <li>Filtering practices</li> <li>Wet ponds and wetlands</li> </ul>		
Harvested forest	Forest harvesting practices	Yes	<ul style="list-style-type: none"> <li>Not yet reported</li> </ul>
Regional planning	Septic connections	Yes	<ul style="list-style-type: none"> <li>Not yet reported</li> </ul>
	Stormwater management BMPs (includes runoff reduction and stormwater treatment practices)		
	Urban stream restoration		
	Urban nutrient management		
	Wetland enhancement/rehabilitation		
Urban forestry	Forest buffer	Yes	<ul style="list-style-type: none"> <li>Not yet reported</li> </ul>
	Forest planting		
	Tree planting (stormwater treatment – runoff reduction)		
WQIP (Water Quality Improvement Project)	Stormwater management BMPs (includes runoff reduction and stormwater treatment practices)	Yes	<ul style="list-style-type: none"> <li>Not yet reported</li> </ul>
	Stream BMPs		
	Forest Buffers		
	Forest planting		
	Grass buffers		
	Wetland enhancement/rehabilitation		
MS4	Various BMPs	No	<ul style="list-style-type: none"> <li>Not yet reported</li> <li>BMPs associated with MS4 permits in Binghamton and Elmira will not be included in the verification protocol because there is an existing tracking and reporting requirement through the MS4 permit.</li> </ul>
Federal facilities	Various BMPs	No	<ul style="list-style-type: none"> <li>Not included. Federal facilities have their own verification procedures.</li> </ul>

## 2.3 Number and Type of Sites

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DEC has provided the following estimates of the types and number of developed sector BMPs expected to be reported in New York's BMP database for the Chesapeake Bay watershed. The actual numbers of each BMP type are unknown at this time, therefore, the statistical survey design (see Section [ REF \_Ref48650913 \r \h ] ) was developed using a synthetic dataset of estimated numbers. The BMPs types and estimated number of BMPs used to develop the statistical survey procedures are described below:

- Construction Stormwater – Approximately 300 construction projects will be added to the database. Each construction project will have, at a minimum, a runoff reduction and/or stormwater treatment BMP.
- Harvested Forest – This practice represents timber sales on DEC state forest. Annual forest harvesting BMPs are approximately 10 to 30 per year.
- Regional Planning – The regional planning boards are currently conducting a survey to send to municipalities to estimate the amount of BMPs being implemented in the watershed outside of MS4 areas.
- Urban Forestry – Approximately 10 to 15 projects with possible tree planting BMPs.
- WQIP – Approximately 40 projects. It is difficult to estimate the amount of BMPs for each WQIP project as they vary significantly from stream restoration to green infrastructure implementation.

## 3.0 Statistical Sample Design

The statistical sample design for the verification procedures is based on the numeric verification goals outlined in the CBP's *Urban Stormwater Verification Guidance* (CBP 2014), the types of BMPs DEC is planning to report, and the number of BMPs to be reported. These deciding factors are discussed below and are combined to determine the required sample size for verification.

### 3.1 Sample design goal

New York's developed sector QAPP (NYSDEC 2019) discusses DEC's current effort to perform verification on a sample of their BMP inventory at least once during the credit duration/lifespan of the BMP. The QAPP states:

"Non-MS4 communities may elect to reduce the scope of their visual inspections by subsampling a representative fraction of their local BMPs and applying the results to their entire population of BMPs that are credited in the model. The sub-sampling method will be designed to have at least an 80% confidence level that the BMPs are reported accurately. There are several well accepted approaches to determining the sample size. These include using a census for a small population of BMPs, imitating a sample size of similar studies, using published tables, and/or applying formulas to calculate a sample size" (NYSDEC 2019).

The above approach to sample a representative fraction of the local BMPs is supported by the *Urban Stormwater Verification Guidance* (CBP 2014).

Tetra Tech consulted with Tom Schueler and David Wood of the Chesapeake Stormwater Network who are members of the CBP's developed sector Expert Panel as well as Jeff Sweeney at CBP and Norm Goulet, chair of the Urban Stormwater Workgroup. In a joint discussion with DEC staff and the aforementioned individuals, it was recommended that the 80% confidence level be used in conjunction with achieving a  $\pm 10$  percent confidence interval (e.g., stormwater runoff reduction BMPs were successfully implemented with a  $75\% \pm 10\%$  [65%-85%]).

### 3.2 Impact of site type on sample design

The differences in the number and type of sites (see Section [ REF \_Ref47707166 \r \h ]) was also noted in the above conversation. Because of these differences, it was determined that two separate random selection processes be created for two groups of sites: 1) construction stormwater sites and 2) other developed sector sites.

**Construction stormwater sites.** Random selection of construction stormwater sites will be performed in a fashion similar to the approach used for selecting agricultural sites in the statistical survey procedures for agricultural sector BMP verification developed in 2016 (Tetra Tech 2016). The similar approach is the result of the larger number (300-400) of construction stormwater sites in comparison to the number of sites for the other developed sector site types. This approach involves the following steps:

- Create an inventory of known sites and county location.
- Create an inventory of BMPs implemented at each site.
- Randomly select one site from each county.
- Randomly select additional sites, one at a time, until the targeted number of BMPs have been selected for verification.
  - Sites are targeted based on the county-level stratification. Counties with more BMPs will have more sites identified for verification.
- All BMPs at a given site are inspected.
  - Inspecting all BMPs at a site will usually result in over sampling for some BMP types.

**Other developed sector sites.** The process for selecting other developed sector sites is similar to construction stormwater excepts sites will be stratified by site type (harvested forest, regional planning, urban forestry, WQIP) instead of county.

### 3.3 Sample size

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Based on the sample design discussion provided in Section [ REF \_Ref47713765 \r \h ], the objective of the verification monitoring study is designed to estimate the proportion of properly implemented BMPs to within  $\pm 10$  percent confidence interval with an 80% confidence level.

USEPA (2001) presents a method for computing the confidence intervals for distributions that follow a binomial distribution, such as BMP inspections with a pass/fail outcome and have a finite population from which samples are drawn. The benefit of this method is that smaller samples can be drawn, thereby reducing stakeholder cost and burden in comparison to the “large-population” approach. In addition, evidence (i.e., based on a previous survey) that can inform the likely proportion of BMPs passing can also be used to inform the sample size needed to meet the above objective. If no information is available, the sample size calculation should be based on a proportion of 50 percent. It might be reasonable to assume that a higher proportion of BMPs would pass an inspection.

[ REF \_Ref48653392 \h ] presents the half-width confidence interval for a variety of population sizes (30, 50, 100, 200, 300, 400), sampling efforts (5%, 10%, 15%, 20%, 25%, 30%, 40%, 50%, 60%), and proportion of BMPs passing (perc. meet. = 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.90) for an 80 percent confidence level. As stated in the previous paragraph, if no information is available to inform the likely proportion of BMPs passing, then the user should select the column, “80% Conf. Level (w/ perc. meet. = 0.5)”. The green checks indicate sampling scenarios that meet the study objectives.

DEC's stormwater permitting section does not currently know the percentage of BMPs expected to pass inspection, therefore, it is assumed that 50% of the practices will pass. This value may change with more knowledge gained in future years (see Section [ REF \_Ref48654007 \r \h \\* MERGEFORMAT ]).

Based on the lack of information regarding BMP success rate and the half-width confidence interval information presented in [ REF \_Ref48653392 \h \\* MERGEFORMAT ], an example of the verification sampling procedure for construction stormwater BMPs is presented here. Suppose DEC inspected 30 of 300 construction stormwater runoff reduction BMPs and found that 15 sites had passed the inspection (i.e.,  $p=0.50$ ). In this case, it can be stated that with 80% confidence, the percentage of sites correctly implementing runoff reduction is  $50 \pm 11\%$ . On the other hand, suppose 15 sites were inspected and 12 sites passed ( $p=0.80$ ). In this case, it can be stated that with 80% confidence, the percentage of sites correctly implementing runoff reduction is  $80 \pm 13\%$ . Neither one of these sampling options is acceptable as they do not meet the requirement of 80% confidence level  $\pm 10\%$  (see [ REF \_Ref48656140 \h \\* MERGEFORMAT ]).

However, if DEC inspected 45 of 300 runoff reduction BMPs and found that 23 sites passed inspection (i.e.,  $p=0.50$ ), it can be stated with 80% confidence that the percentage of sites correctly implementing runoff reduction is  $50 \pm 9\%$ . This sample size is acceptable, with 15% sampling of the population of 300 and a percent meeting of 0.5 (50%). This sample size meets the 80% confidence level  $\pm 10\%$  as can be seen by the green check under the 15% sample size for 300 entities with perc. meet.=0.50 ([ REF \_Ref48656140 \h ]). Based on the information presented in [ REF \_Ref48656140 \h \\* MERGEFORMAT ], an acceptable sampling scenario for New York's 300-400 construction stormwater BMPs falls between 10% (for 400 BMPs) and 15% (for 300 BMPs).

The examples above are based on construction stormwater BMPs but this same methodology can also be applied to the “other developed sector sites” discussed in Section [ REF \_Ref48743684 \r \h \\* MERGEFORMAT ].

Table [ SEQ Table \\* ARABIC ]. Binomial confidence interval for varying sampling efforts and estimated probabilities of success

Sample Lev.	Number of Entities Implementing Practice	Minimum Selection Target	Half-width Confidence Interval (+/-d, %)									
			80% Conf. Level (w/ perc. meet. = 0.5)	80% Conf. Level (w/ perc. meet. = 0.55)	80% Conf. Level (w/ perc. meet. = 0.6)	80% Conf. Level (w/ perc. meet. = 0.65)	80% Conf. Level (w/ perc. meet. = 0.7)	80% Conf. Level (w/ perc. meet. = 0.75)	80% Conf. Level (w/ perc. meet. = 0.8)	80% Conf. Level (w/ perc. meet. = 0.85)	80% Conf. Level (w/ perc. meet. = 0.9)	
5% Sample	30	2	44%	44%	43%	42%	40%	38%	35%	31%	26%	
	50	3	38%	38%	35%	34%	31%	31%	29%	26%	22%	
	100	5	28%	28%	27%	27%	26%	24%	22%	20%	17%	
	200	10	20%	20%	19%	19%	18%	17%	16%	14%	12%	
	300	15	16%	16%	16%	15%	15%	14%	13%	12%	10%	
	400	20	14%	14%	14%	13%	13%	12%	11%	10%	8%	
10% Sample	30	3	35%	35%	34%	33%	32%	30%	28%	25%	21%	
	50	5	27%	27%	27%	26%	25%	24%	22%	19%	16%	
	100	10	19%	19%	19%	18%	18%	17%	15%	14%	12%	
	200	20	14%	14%	13%	13%	12%	12%	11%	10%	8%	
	300	30	11%	11%	11%	11%	10%	10%	9%	8%	7%	
	400	40	10%	10%	9%	9%	9%	8%	8%	7%	6%	
15% Sample	30	5	26%	26%	26%	25%	24%	23%	21%	19%	16%	
	50	8	21%	21%	20%	20%	19%	18%	17%	15%	12%	
	100	15	15%	15%	15%	15%	14%	13%	12%	11%	9%	
	200	30	11%	11%	11%	10%	10%	9%	9%	8%	6%	
	300	45	9%	9%	9%	8%	8%	8%	7%	6%	5%	
	400	60	8%	8%	7%	7%	7%	7%	6%	5%	5%	
20% Sample	30	6	22%	22%	21%	22%	21%	20%	19%	17%	14%	
	50	10	18%	18%	18%	17%	17%	16%	14%	13%	11%	
	100	20	13%	13%	13%	12%	12%	11%	10%	9%	8%	
	200	40	9%	9%	9%	9%	8%	8%	7%	6%	5%	
	300	60	7%	7%	7%	7%	7%	6%	6%	5%	4%	
	400	80	6%	6%	6%	6%	6%	6%	5%	5%	4%	
25% Sample	30	8	19%	19%	19%	19%	18%	17%	16%	14%	12%	
	50	13	15%	15%	15%	15%	14%	13%	12%	11%	9%	
	100	25	11%	11%	11%	11%	10%	10%	9%	8%	7%	
	200	50	8%	8%	8%	7%	7%	7%	6%	6%	5%	
	300	75	6%	6%	6%	6%	6%	6%	5%	5%	4%	
	400	100	6%	6%	5%	5%	5%	5%	4%	4%	3%	
30% Sample	30	9	18%	18%	18%	17%	16%	15%	14%	13%	11%	
	50	15	14%	14%	14%	13%	13%	12%	11%	10%	8%	
	100	30	10%	10%	10%	9%	9%	8%	8%	7%	6%	
	200	60	7%	7%	7%	7%	6%	6%	6%	5%	4%	
	300	90	6%	6%	6%	5%	5%	5%	5%	4%	3%	
	400	120	5%	5%	5%	5%	4%	4%	4%	3%	3%	
40% Sample	30	12	14%	14%	14%	14%	13%	12%	11%	10%	9%	
	50	20	11%	11%	11%	11%	10%	10%	9%	8%	7%	
	100	40	8%	8%	8%	7%	7%	7%	6%	6%	5%	
	200	80	6%	6%	5%	5%	5%	5%	4%	4%	3%	
	300	120	5%	5%	4%	4%	4%	4%	4%	3%	3%	
	400	160	4%	4%	4%	4%	4%	4%	3%	3%	2%	
50% Sample	30	15	12%	12%	11%	11%	11%	10%	9%	8%	7%	
	50	25	9%	9%	9%	9%	8%	8%	7%	6%	5%	
	100	50	6%	6%	6%	6%	6%	6%	5%	5%	4%	
	200	100	5%	5%	4%	4%	4%	4%	4%	3%	3%	
	300	150	4%	4%	4%	4%	3%	3%	3%	3%	2%	
	400	200	3%	3%	3%	3%	3%	3%	3%	2%	2%	
60% Sample	30	18	10%	10%	9%	9%	9%	8%	8%	7%	6%	
	50	30	7%	7%	7%	7%	7%	6%	6%	5%	4%	
	100	60	5%	5%	5%	5%	5%	5%	4%	4%	3%	
	200	120	4%	4%	4%	4%	3%	3%	3%	3%	2%	
	300	180	3%	3%	3%	3%	3%	3%	2%	2%	2%	
	400	240	3%	3%	3%	2%	2%	2%	2%	2%	2%	



## 4.0 Impact on QAPP

### 4.1 Semi-regulated construction stormwater BMPs

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The draft statistical survey procedures presented in Section [ REF \_Ref48650913 \r \h ] of this memo will apply to the semi-regulated construction stormwater BMPs outside of MS4 areas as discussed in Section 7.2.2 of New York's developed sector QAPP, which discusses the verification of developed sector BMP data in New York's portion of the Chesapeake Bay watershed (NYSDEC 2019). These BMPs fall under the construction stormwater general permit. Construction stormwater BMPs are currently given full performance credit for the first five years of the BMP's lifespan and then receive a 20% downgrade for each year over the next five years (NYSDEC 2019). The draft sampling survey procedures outlined in this memo will alter this existing process by performing visual inspections on a statistical subsample of all construction stormwater BMPs after the fifth year of their lifespan.

The existing language can be removed from the QAPP and Section 7.2.2 of the QAPP will include a reference to a new appendix (Appendix 1) that will outline the updated verification protocols for semi-regulated BMPs in the developed sector. Table 5 and Table 10.7 in the QAPP currently present the jurisdiction verification protocol design table for construction stormwater BMPs outside of MS4 areas (see Figure 1). Section E of Table 5 (and Table 10.7) will be updated to include a reference to Appendix 1 of the QAPP, which will also describe the methods for conducting field inspections via statistical subsample.

This is similar to the method used to include statistical subsampling in the *Upper Susquehanna Coalition Quality Assurance Project Plan Procedures for Collecting, Reporting, and Verifying Nonpoint Source Data in the Chesapeake Bay Watershed* (Upper Susquehanna Coalition 2019) for verification of agricultural BMPs. The agriculture statistical survey methodology was included as an appendix to the existing nonpoint source QAPP. Construction stormwater BMPs will be surveyed in a similar fashion to the agricultural BMPs because of their larger number (300-400). A percentage of sites will be verified across the watershed at a proportion consistent with the number of sites at the county level. DEC staff in each county will be verifying the BMPs.

[ REF \_Ref49156096 \h ] presents a summary of the draft verification requirements for construction stormwater BMPs.

Verification Element	Description
BMP or Group	Construction Stormwater
Geographic Scope	Outside of MS4 localities
A. WIP Priority	Medium
B. Data Grouping	
C. BMP Type	Post Construction BMPs
D. Initial Inspection	
Method	Field Visit
Frequency	Once
Who Inspects	Qualified Inspector - a person that is knowledgeable in the principles and practices of erosion and sediment control, such as a licensed Professional Engineer, Certified Professional in Erosion and Sediment Control (CPESC), Registered Landscape Architect, or other Department endorsed individual(s).
Documentation	Construction Stormwater Notice of Intent and Notice of Termination
E. Follow-up Check	
Follow-up Inspection	Field inspection of statistical sub-sample TBD
Who Inspects	TBD
Documentation	Verification/Inspection Form

**Figure [ SEQ Figure \\* ARABIC ]. Jurisdiction verification protocol design table: construction stormwater (Table 5 in NYSDEC 2019 QAPP).**

## 4.2 Other developed sector BMPs

Section 8 of the QAPP states that New York does not currently report forestry data but is in the process of developing a data collection (NYSDEC 2019). This is also true for the regional planning, urban forestry and WQIP BMPs listed in [ REF \_Ref44325724 \h ]. In addition to the construction stormwater BMPs, the statistical sampling procedures presented in Section [ REF \_Ref48650913 \r \h ] (to be included in Appendix 1) will also be applied to these “other” developed sector BMPs that have not historically been reported to the CBP (see Section [ REF \_Ref47707166 \r \h ]). Section 8 of the QAPP will be revised to include regional planning, urban forestry and WQIP BMPs and will reference the statistical sampling procedures in Appendix 1.

These “other” urban BMPs in New York’s nonpoint source database are fewer in number than the construction stormwater BMPs and will likely be combined by type across the different programs and BMP templates rather than county (see Section [ REF \_Ref48743684 \r \h \\* MERGEFORMAT ]) unless there are larger amounts of the BMPs than previously thought. These practices are still in the process of being inventoried, therefore, exact counts are unknown. These other developed sector BMPs may not need partitioning across counties because of their small numbers. For these other BMPs, “county” will be swapped out for “BMP template” type (i.e., harvested forest, regional planning, urban forestry and WQIP) as presented in [ REF \_Ref44325724 \h \\* MERGEFORMAT ]. Staff associated with each of the particular programs will be verifying the BMPs (e.g., DEC and regional planning staff).

The statistical subsampling methodology presented in Section [ REF \_Ref48650913 \r \h \\* MERGEFORMAT ] can be applied to these other developed sector BMPs as well. However, it should be noted that statistical subsampling may not be necessary for these BMPs. If large numbers of these types of BMPs do not exist as they do for construction stormwater, a better option may be to inspect 100% of these BMPs at the end of their lifespan rather than as a percentage of the total number of BMPs. For example, all BMPs with a 5-year lifespan will be

inspected after year 5. Section [ REF \_Ref48828928 \r \h \\* MERGEFORMAT ] below describes the adaptive management that will guide the sampling and verification process as new information becomes available.

Although BMPs implemented in MS4 permitted areas and at federal facilities will not be included in the updated verification protocols because they have existing programs for reporting and verifying BMPs, it should be noted that New York's MS4 permit is currently being revised. If a final version of the updated MS4 permit is available before the final updates to the developed sector QAPP are completed, a summary of any changes to the MS4 permit's reporting and verification program will be included.

[ REF \_Ref49156096 \h ] presents a summary of the draft verification requirements for each of the developed sector BMP types.

**Table [ SEQ Table \\* ARABIC ]. Draft verification requirements for each of the developed sector BMP types**

Program type	Practice type	Initial verification (via desktop inventory)	Follow-up or re-verification (via visual inspection)
Construction stormwater	Multi-year	100% (DEC will confirm the number of existing practices on the ground)	Statistical subsample of 10-15% of randomly selected practices in the watershed (see [ REF _Ref48656140 \h \* MERGEFORMAT ] for guidance), distributed across all counties. Sampling percentage may change based on an adaptive management approach (see Section [ REF _Ref48828928 \r \h ]).
Harvested forest	Multi-year	100% (DEC will confirm the number of existing practices on the ground)	Statistical subsample of a percentage (see [ REF _Ref48656140 \h \* MERGEFORMAT ] for guidance) of these BMPs as a group across program type rather than county OR inspect 100% of these BMPs at the end (after 5 <sup>th</sup> year) of their lifespan. Sampling percentage and procedure may change based on an adaptive management approach (see Section [ REF _Ref48828928 \r \h ]).
Regional planning			
Urban forestry			
WQIP			

### 4.3 Adaptive Management

Because of the lack of knowledge regarding the current number of developed sector BMPs on the ground and uncertainty regarding the expected percentage of BMPs to pass inspection, the draft statistical subsampling design presented in Section [ REF \_Ref48650913 \r \h \\* MERGEFORMAT ] was based on a statistically conservative assumption that 50% of the BMPs will pass inspection. In reality, these numbers will change as New York's verification program begins and more knowledge is gained. Regardless of the initial sampling method used, an adaptive management approach will be applied to the verification program to ensure that sampling rates remain within range of the target of 80% confidence level  $\pm$  10% as presented in Section [ REF \_Ref48650913 \r \h \\* MERGEFORMAT ].

[ REF \_Ref48831144 \h \\* MERGEFORMAT ] will be included in Appendix 1 of the revised QAPP to be used to guide future sample size selections. DEC staff can use [ REF \_Ref49161232 \h ] to pick the correct sampling values based on the 80% confidence level  $\pm$ 10%. [ REF \_Ref48831144 \h \\* MERGEFORMAT ] is the same as [ REF \_Ref48656140 \h \\* MERGEFORMAT ] but does not have the green checkmarks indicating the acceptable sampling scenarios. DEC can use this table to apply appropriate sampling scenarios once they have a better understanding of the percentage of BMPs expected to pass inspection. The current percentage of BMPs expected to pass inspection is assumed to be 50% because there is no information available, but the actual percentage is likely different than 50%.

As implementation and verification of developed sector BMPs progresses, the percent meeting and other information will be used to help assess the need to alter the sampling approach. As New York's verification program becomes more robust, the actual percent meeting (perc. meet. in [ REF \_Ref48831144 \h \\* MERGEFORMAT ]) will become known and can replace the 50% assumption. The 80% confidence level  $\pm 10\%$  will still be required but the perc. meet. will be adjusted to the columns to the right to reflect the actual percent meeting (e.g., 55 – 90%). Adjustments will be made as necessary to ensure that verification goals are met. The sample size can and likely will change over time. Subsampling will start on the left of [ REF \_Ref48831144 \h ] (using 50% perc meet.) and likely move to the right with a larger perc meet. as the actual percentage of BMPs passing inspection becomes available. DEC can adaptively manage the sample size over time as the increasing perc. meet. will reduce the necessary sample size to meet the 80% confidence level  $\pm 10\%$ . The percentage of BMPs sampled will vary depending on the number of practices (e.g., a larger number of BMPs will have a smaller sampling percentage; a smaller number of BMPs will have a larger sampling percentage).

Table [ SEQ Table \\* ARABIC ]. Binomial confidence interval for varying sampling efforts

Sample Lev.	Number of Entities Implementing Practice	Minimum Selection Target	Half-width Confidence Interval (+/-d, %)									
			80% Conf. Level (w/ perc. meet. $\approx 0.5$ )	80% Conf. Level (w/ perc. meet. $\approx 0.55$ )	80% Conf. Level (w/ perc. meet. $\approx 0.6$ )	80% Conf. Level (w/ perc. meet. $\approx 0.65$ )	80% Conf. Level (w/ perc. meet. $\approx 0.7$ )	80% Conf. Level (w/ perc. meet. $\approx 0.75$ )	80% Conf. Level (w/ perc. meet. $\approx 0.8$ )	80% Conf. Level (w/ perc. meet. $\approx 0.85$ )	80% Conf. Level (w/ perc. meet. $\approx 0.9$ )	
5% Sample	30	2	44%	44%	43%	42%	40%	38%	35%	31%	26%	
	50	3	36%	36%	35%	34%	31%	31%	29%	26%	22%	
	100	5	28%	28%	27%	27%	26%	24%	22%	20%	17%	
	200	10	20%	20%	19%	19%	18%	17%	16%	14%	12%	
	300	15	16%	16%	16%	15%	15%	14%	13%	12%	10%	
	400	20	14%	14%	14%	13%	13%	12%	11%	10%	8%	
10% Sample	30	3	35%	35%	34%	33%	32%	30%	28%	25%	21%	
	50	5	27%	27%	27%	26%	25%	24%	22%	19%	16%	
	100	10	19%	19%	19%	18%	18%	17%	15%	14%	12%	
	200	20	14%	14%	13%	13%	12%	12%	11%	10%	8%	
	300	30	11%	11%	11%	11%	10%	10%	9%	8%	7%	
	400	40	10%	10%	9%	9%	9%	8%	8%	7%	6%	
15% Sample	30	5	26%	26%	26%	25%	24%	23%	21%	19%	16%	
	50	8	21%	21%	20%	20%	19%	18%	17%	15%	12%	
	100	15	15%	15%	15%	15%	14%	13%	12%	11%	9%	
	200	30	11%	11%	11%	10%	10%	9%	9%	8%	6%	
	300	45	9%	9%	9%	8%	8%	8%	7%	6%	5%	
	400	60	8%	8%	7%	7%	7%	7%	6%	5%	5%	
20% Sample	30	6	23%	23%	23%	22%	21%	20%	19%	17%	14%	
	50	10	18%	18%	18%	17%	17%	16%	14%	13%	11%	
	100	20	13%	13%	13%	12%	12%	11%	10%	9%	8%	
	200	40	9%	9%	9%	9%	8%	8%	7%	6%	5%	
	300	60	7%	7%	7%	7%	7%	6%	6%	5%	4%	
	400	80	6%	6%	6%	6%	6%	6%	5%	5%	4%	
25% Sample	30	8	19%	19%	19%	19%	18%	17%	16%	14%	12%	
	50	13	15%	15%	15%	15%	14%	13%	12%	11%	9%	
	100	25	11%	11%	11%	11%	10%	10%	9%	8%	7%	
	200	50	8%	8%	8%	7%	7%	7%	6%	6%	5%	
	300	75	6%	6%	6%	6%	6%	6%	5%	5%	4%	
	400	100	6%	6%	5%	5%	5%	5%	4%	4%	3%	
30% Sample	30	9	18%	18%	18%	17%	16%	15%	14%	13%	11%	
	50	15	14%	14%	14%	13%	13%	12%	11%	10%	8%	
	100	30	10%	10%	10%	9%	9%	8%	8%	7%	6%	
	200	60	7%	7%	7%	7%	6%	6%	6%	5%	4%	
	300	90	6%	6%	6%	5%	5%	5%	5%	4%	3%	
	400	120	5%	5%	5%	5%	4%	4%	4%	3%	3%	
40% Sample	30	12	14%	14%	14%	14%	13%	12%	11%	10%	9%	
	50	20	11%	11%	11%	11%	10%	10%	9%	8%	7%	
	100	40	8%	8%	8%	7%	7%	7%	6%	6%	5%	
	200	80	6%	6%	5%	5%	5%	5%	4%	4%	3%	
	300	120	5%	5%	4%	4%	4%	4%	4%	3%	3%	
	400	160	4%	4%	4%	4%	4%	3%	3%	3%	2%	
50% Sample	30	15	12%	12%	11%	11%	11%	10%	9%	8%	7%	
	50	25	9%	9%	9%	9%	8%	8%	7%	6%	5%	
	100	50	6%	6%	6%	6%	6%	6%	5%	5%	4%	
	200	100	5%	5%	4%	4%	4%	4%	4%	3%	3%	
	300	150	4%	4%	4%	4%	3%	3%	3%	3%	2%	
	400	200	3%	3%	3%	3%	3%	3%	3%	2%	2%	
60% Sample	30	18	10%	10%	9%	9%	9%	8%	8%	7%	6%	
	50	30	7%	7%	7%	7%	7%	6%	6%	5%	4%	
	100	60	5%	5%	5%	5%	5%	5%	4%	4%	3%	
	200	120	4%	4%	4%	4%	3%	3%	3%	3%	2%	
	300	180	3%	3%	3%	3%	3%	3%	2%	2%	2%	
	400	240	3%	3%	3%	2%	2%	2%	2%	2%	2%	

## 5.0 References

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